Spatial Study as an Integration Approach of Digital Technology in Wayfinding Design to Enhance Hospitals Sustainability Aspect in Jakarta

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Abstract. Hospitals in Jakarta face the problem of ineffectiveness in providing information regarding directions within the hospital because it still depends on the staff on duty. Also, different flow activities with multiple destinations depend on each patient case. This situation causes crowd points in some intersection areas; this is detrimental to the patient because much time is wasted in their medical journey. The application of GPS technology will reduce patient’s traveling time in doing some activities such as registration, queuing, doctors’ consultation, lab checks, payment, and other administration matters, by guiding the patient through the path shown in their mobile apps, which integrate with the signage in the hospitals. This research was conducted by qualitative data analysis through design simulation methods and data collection of facilities and activities in Jakarta’s hospital. The research focused on patients with Government Health Insurance (BPJS). GPS-based mobile apps are the solution to improve the condition so that the flow of activities within the hospital can run effectively and achieve a level of comfort for the patients, providing adequate, accessible, and easily understood information by the patients and achieving sustainability in health services.

1. Introduction

Hospital with its intricacy, is facing the hard times in delivering effective services, consider the increasing number of visitors and the limited space. Patients come along with variety of medical records are required to be facilitated by sufficient spaces, types of examination, diverse medical treatment, and so on and so forth. Considering the various types of complex space functions, hospital make its building obliged to implement a wayfinding system in its interior, aiming to make it easier for room users to reach the destination quickly and safely. Wayfinding itself, is a method used by facility users to be able to achieve their goals by tracing the direction of the circulation in the space. It is often found that the implementation of the wrong wayfinding will have a bad effect on the users. Wayfinding can be concluded as a process in problem solving [1] in terms of determining and navigating the direction to a destination and knowing the area when approaching it [2]. The lack of wayfinding implementation will be more problematic if the space user is a person who has limited vision and physical mobility [3]. Even more, unclear massage on the signage or wrong positioning of the information board can make it worse.

Some researchers have revealed that effective hospital wayfinding system can improve patient experiences, encourage the emergency management to be better, and introduce the efficiency of medical staff [4]. Ineffective wayfinding in common areas can cause disruption. It will be impacted to the stress level of the staffs [5]. Poor wayfinding design in a hospital will have a negative impact on many parties, including patients, visitors, nurses, and the entire image of the hospital management. The whole aspects that are implicated on ineffective wayfinding can accumulate on bad impression of the hospital [6]. From the view of economic and social sustainability, it is not the recommended way for the hospital to run their business along with the mission of humanity. In contrast, a good wayfinding design will increase efficiency in finding the right place, and of course will improve the user experience at the hospital. In short, we can see that wayfinding is also playing an important role to hospital ergonomic aspect due to its relation to the effectivity of a space to accommodate human activities in acquired better health services.

Being lost, undeniably leads to an increasing stress level, which are already taxed by ill health or anxiety [7]. Lost, in this context is telling more about missing the sequences of services, misleading the information of destination room, and trapped in a crowd causing the time of waiting getting longer. When there are blockages in the flow of patient care, it can increase the amount of time patients must wait, which creates a negative effect on the quality of services delivery. Another research has illustrated that positive experiences of the patients are bringing comfort which can promote their health [8]. They assume that better environment, indirectly, could possibly bring sustainability environment. From the data collected, the

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research shown that one of the crucial elements to improve psychosocially sustainable hospital should consider crowding and installed symbolic landmark. This problem occurs not only in the hospital at the large scale, but also in the smaller units such as polyclinic, pharmacy, and other healthcare installation.

According to the analysis, it is understandable if wayfinding become one of space quality parameters that support the service quality in circulation functionality in public facilities [9]. On this view, the basic problem of wayfinding can be later a destruction as disorienting spaces aggravated by renovation and additions in the hospital building [10]. Building development means the hospital is developing new ways to find. It is distracting circulation and produces people crowd. Accumulation of visitor density in certain areas also create blockages of patients which later can be inefficient for the users to find destination areas and prolonging duration of services.

At the hospital level, Data-driven operational decision-support systems can provide valuable insights to aid in making triage, admission, and discharge decisions [11]. For example, a decision-support algorithm can provide recommendations based on the predicted benefit of ICU admission for particular patient, it can also be used to predict the expected number of admissions, discharges, and transfers to and from the ward, it can predict nurse absenteeism rates and the need for surge staffing.

This is another important area where digital technology can bring substantial improvements, not only by better predicting resource needs, optimizing schedules based on the latest research, but also in order to be integrated with the existing system based on the patient needs management, this digital system should provide information regarding to the location of the intended ward so that patients can effectively and precisely go to the location.

Global positioning system (GPS) is a network of satellites or a space-based radio-navigation system that broadcasts highly accurate navigation pulses to users on or near Earth. Some GPS receivers are so accurate they can establish their location within 1 centimetre [12]. GPS consists of satellites, ground stations, and receivers.

GPS using the navigation satellites that sending out signals which are picked up by the radars from the ground stations to confirm where the satellites are, and the satellites gives you information about where a person stand on the ground [13]. The stream of communication between the ground and the satellites is a device with a GPS receiver, for example a smartphone, a GPS watch, a drone, the sat-nav in a car, etc. When the GPS receiver turned on, it can pinpoint the user’s location. Knowing the user’s location can help to navigate a certain destination and it can communicate it to anyone that has the same apps.

GPS satellites send signals for civilian use at the L1 frequency at 1.575 GHz; these signals are modulated with a Pseudo-Random Noise (PRN) code unique to each satellite. A GPS receiver tries to acquire each GPS satellite’s signal by correlating the signal spectrum it receives at L1 with a local copy of the satellite’s PRN code [14].

GPS apps based on mobile is the newest technology that help humans in knowing about their whereabouts quickly and accurately. Even this technology is a very appropriate solution because it will really help hospital visitors at times when they need information on fast and precise directions to where they want to go [15]. Therefore the recommendation of wayfinding system in GPS-based mobile phone can also be used as a guidance for the patients’ flow of activities, and future building development in order to ensure the effectiveness of circulation and areas connectedness.

From this elaboration we can conclude the basic problems of wayfinding in hospital areas emerges along with the complex space function, insufficient signage, patient crowd and circulation blockages. Those problems can perform as spatial sustainability issue of the hospital as it is connected to several aspects such as psychosocially supportive design. So, with the right placement of signage that runs with mobile app technology, it will help hospital users to navigate without confusion, and arrived on schedule. GPS apps based on mobile technologies also will reduce traveling time with integration of payment, registration, queuing, and other admiration matters. Avoiding crowds and lowering stress levels will indirectly improve the patient’s health and also produce positive effect on the quality of service delivery, and all of these effects will improve the psychosocially sustainable hospital.

2. Methods

This study investigates the possibility of wayfinding and spatial ability to embrace the sustainability aspect in hospital. The aspects of sustainability are aiming to provide efficient services that are closely related to the hospital management and patient experiences. The experience covers the time they spent on their visits, the aspect of proxemics, and any other psychosocial aspects while waiting for the medical care/services. To reach the goal, the research will collect pattern of user (patient) activities then creating efficient wayfinding system on the hospital areas. On this research, the patient with Government Health Insurance (BPJS) will be categorized as the user (patient). Therefore, the patient came to the hospital without government health insurance (BPJS) are not included in this discussion.

Data will be analysed based on the hospital characteristics and users’ behaviour (patient activities). Survey will be collected to hospital visitors throughout online survey. The data will represent the users’ perception on the existing building and understand the users’ flow of activity.

The 2nd step is analysing the possible scenario for the hospital wayfinding system. To do so, this research will produce a simulation layout based on the users’ activities. It draws the participants’ most visited areas within the hospital. Random arrangement of the areas will show ineffective way to find a destination areas/room. The analysis process will be considered the
sustainability aspects such as user experiences and possibility of building development.

The 3rd step is the data will determine signages that need to be located in certain area, taken from visitor circulation paths, intersection points and crowded points, which then the signage points at these locations are combined into a GPS-based mobile phone, so that digital information occurs in the form of user's path, destination points and destination directions displayed on the mobile apps.

At the final stage, this research will produce recommendation for the effective wayfinding in hospital. The recommendation is offered to enhance the sustainability aspect in the hospital services. In addition, the recommendation of wayfinding system in GPS-based mobile phone can also be used as a guidance for the future building development, to ensure the effectivity of circulation and areas connectedness.

3. Result and Discussion

Development of the hospital areas oftentimes is considering the cost and availability of the space, rather than interconnectivity of rooms and its functionality. It is creating the way future of hospital building development, which closely related to the user’s flow activity, impacted on the working effectivity, and patient experience, especially in term of the patient wayfinding. According to the random picks of the survey participants answer, below is illustrated the sequence of the patients’ activities within the hospital areas. It shows among of the most visited areas around the hospital are verification area, medical consultation, laboratory, pharmaceutical installation, waiting areas, and inpatient rooms. The room and areas are also identified the density of visitors.

Fig. 1 describes the possibility if patients have a clear information related to the activity flow, it will help patient to build perception of the space then quickly arrive to the destination area. Notably, it is helping visitor and patient to find areas if patient has certain schedule from the beginning of the registration step. Routine schedule for the patient covers medical consultation, Routine drug receipt, Medical and wound treatment, laboratory visit (radiology, common lab., pathology anatomy, etc.), and Therapy (chemotherapy, Rehabilitation therapy, operation, etc.). Data shows on Fig. 1 the sequence of patients’ activity is divided by the service provided by the hospital. Without sufficient guidance for the future building development, increasing visitors, and the spread of hospital services, it is unconsciously has been worsening the interconnectivity of the room/area which can be affected on the crowd point and bad experiences during the hospital visit.

![Fig. 1. Sequence of patients’ activities at Hospital (Author, 2023)](image1)

![Fig. 2. Matrix Study illustrates the area connectedness (Author, 2023)](image2)
From the analysis above, we know that not all the areas have closely related each other. There are several areas need to be connected and the rest need to be adjusted along with the patient flow activities. The factors that have emerged in this literature are intuitive, and include topics such as logical floorplans, clearly understandable directional signs, highly visible landmarks, and architectural designs that prompt movement toward information areas and patient and visitor destinations [16]. From the most visited areas above, a simulation layout was built to see how patient flow activities are driving the way people see their surroundings. It is described on the alternative layout for the floorplan circulation as follows.

Fig. 3. Circulation for the patient and relation to the area positioning on the 1st floor (Author, 2023)

This study records the flow of patient activities, from which it is determined the placement of rooms in the hospital. This layout illustration has planned the placement of the room according to the patient’s needs. Since the beginning of registration, each patient has been confirmed to choose the intended facility room according to the visit plan. The planned visit in question is Consultation, Routine Prescription, Wound Care, PK Lab Check, Radiology Check, PA Check, Radiation, Rehab Therapy, Surgery, and Chemotherapy. So that wayfinding is very possible to be directed since the registration of this visit plan agreement is made by all patients.

After assigning spaces based on the patient’s journey, several points of intersection are generated along the path they take. These points of intersection cause the patient to stop and look for information to go through the path to the next place. The result is the emergence of crowded points, where patients gather in an intersection area, as shown in fig. 4.

These points of intersection and the crown points make the area suitable for placing signage in the form of road markers and direction. The signage itself can contains small information about what to do when they arrive at the next place, so patients don’t have to look for more information. Figure 5 is the Illustration that shows several points to put the signage.

Fig. 4. Crowd point on the hospital area
(Author, 2023)

Fig. 5. Recommendation to put signage and landmark
(Author, 2023)

The results of observations in the field indicate that the circulation of users is highly needed to be effective in finding the destination. Because of the large number of patients with various interests, which cause crossflow of activities and causing crowds that end in ineffective flow of patients which will affect the condition of the patient and other people with the same interest. From this analysis, came out a result of alternative circulation that can make it easier for patients to reach the destination polyclinic and access related units in the hospital.

Fig. 6 shown the steps on how to reach an effective wayfinding integration with the digital technology. It begins with the flow activities of the users including behavior and psychological factors, and then determining the wayfinding by the signage placement.
in the circulation area and apply them in the GPS mobile apps. The result is the integration as the whole process of the activity in the hospital.

Fig. 6. Illustration of the Integration of digital wayfinding (Author, 2023)

Mobile apps in a hospital generally only serve registration and appointment with the doctor. However, by completing with the GPS mobile apps, the user's location will be detected and will appear on the mobile screen at the moment they are inside the building. The rooms that must be visited also will appear.

GPS mobile apps is very useful, especially for BPJS participants or patients who have many rooms to visit. In this apps not only the room, but it will show the most efficient path that can be passed by the patient. Just like how GPS works which connects the ground with satellites in the air, the hospital's GPS mobile apps will have a connection with the ground, namely the hospital layout. Signage will be placed at each intersection or a stop point that will be detected on the mobile apps, so it can show the location and information's by aligning the signage on the ground with the one in the mobile screen. Based on this, GPS system will help to solve some problem in the hospitals concerning the visitors that have difficulties in finding direction inside the hospitals.

4. Conclusion

The following is a conclusion regarding the considerations in determining the necessary signs that affect the smooth flow of the patient:
1. The sequence of activities or steps that must be taken by the patient in each area must be clear.
2. Increase space for each waiting area.
3. Clear separation of the patient's circulation to different polyclinics.
4. The direction sign and the name of the area must be clear and showing the user's path to the destination area.
5. Clear Information Board about required activities.
6. Put signage at the point of intersection of circulation area.

The illustration for patient's directory at a hospital are based on patient's flow of activities, point of intersection, and also the placement of signage and information are expected to be solutions for wayfinding needs and make it easier for patients to get health services in terms of easy accessing to the destination area, relatively gain effective time, and reduced crowds due to reduced waiting times.

To make this type of digital integration of wayfinding possible, hospitals must be intentional in interact between the users and their information technology systems of wayfinding in digital system, there are several recommendations:
1. It is necessary to have a planned hospital visit (as the outpatient) which identified with color code. The color codes are recommended for the hospital as the administrative procedures during the patient hospital visit.
2. The GPS system showed the users standing point and their path to the destination area that integrated with the signage at the hospitals area, and revealed the surrounding area with the crowd of the people.
3. The GPS system showed different colors for patients, emergency patients and medical officers, in order to know which patient that need to have priority in action.
4. Scenarios/alternatives made on the patients’ circulation pattern are expected to be a solution for wayfinding needs and make it easier for patients to get health services, in terms of ease of accessing the destination area, relatively shorter time, and reduced crowd due to reduced waiting times.

Development along with technology-related field to formulate a system that cause the spatial recommendation cannot stand alone. It has to be supported by the system to ease the crowd.

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